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# PERMANENT CHANGE OF STATION (PCS) COST-GENERATION MODEL (PCSMOD)

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# PERMANENT CHANGE OF STATION (PCS) COST-GENERATION MODEL (PCSMOD)

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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)


Increasing permanent change of station (PCS) budget outlays have prompted recent studies on military assignment policies and on PCS-related issues. This report describes and tests a model that automatically computes PCS costs. A network of all Navy duty stations in the U.S. is first constructed and transformed into mathematical form. A shortest-path algorithm is then applied to the network to determine the distance between


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any two stations. This estimated distance, the individual's pay grade, and number of dependents are then used to compute total PCS cost. The resulting automated system is more efficient than is the present practice of manually consulting official distance and cost tables.

## FOREWORD

This project was conducted under RF-63-521-804 (Manpower and Personnel Technology). It evolved as part of exploratory task RF63-521-001-010-03.06 (Career Management Planning) under the sponsorship of the Office of Naval Research. The overall objective of the task is to construct a career management model that optimizes cost, performance, and retention in planning the sequence of duty assignments of enlisted Navy personnel. This report describes a model for use in estimating permanent change of station (PCS) costs incurred in the assignment process. This model is intended for use by military detailing personnel as well as manpower and personnel managers.

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## SUMMARY

### Problem

The military services are continually confronted with seemingly unmanageable personnel assignment problems. During FY83, approximately 1,300,000 permanent change of station (PCS) moves were initiated by the Navy. However, since PCS funds are increasingly constrained by a tighter budget, procedures to reduce PCS costs without compromising military effectiveness have to be devised.

One step in controlling PCS outlays is to upgrade PCS cost computation. At present, PCS cost estimation involves a manual search through official distance and cost tables. This process is inefficient and error-prone.

### Objective

The purpose of this effort was to develop a new PCS cost-estimation model that automates the process of calculating the cost of a PCS move. The tedious tasks of paging through the official tables of distances and PCS costs are replaced by a network model that integrates the computations of mileage and cost in one operation.

### Approach

PCS costs are computed automatically by the following procedure:

1. The network structure of Navy duty stations in the continental U.S. (CONUS) is represented in matrix form.

2. A linear optimization algorithm is developed to find the shortest path between any pair of stations in the network.

3. The estimated total distance of this path, the individual's pay grade, and the number of dependents are input into a PCS cost generation model (PCSMOD) that computes the total PCS cost of a move.

### Results and Conclusions

The network model performed impressively: Shortest-path distances deviated from official mileages by an average error of 2 percent. No problems were encountered in specifying the appropriate costs of sample itineraries. PCSMOD has successfully combined in a single operation the previously unautomated tasks of distance and PCS cost computation. Thus, PCSMOD solves two complex problems. First, its output serves as input to the career management planner, which optimizes over total PCS expenditures, performance, and retention in planning optimal career assignments. Second, it can be used in place of official distance and PCS cost tables to facilitate the Navy's PCS costing operation. Also, PCSMOD allows managers to keep track of the PCS budget balance.

### Recommendations and Future Plans

Navy Military Personnel Command (NMPC-4) should implement PCSMOD to estimate the cost of CONUS moves as part of the enlisted detailing process. As a result of the successful development of PCSMOD, it is further recommended that an enhanced version

of PCSMOD that includes both overseas and officer assignments be developed by NAVPERSRANDCEN for NMPC-4 implementation as part of the detailing/order writing process.

Technically, it is recommended that further increases in speed be researched by NAVPERESRANDCEN by adding additional arcs (direct routes) connnecting major Navy bases.

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## INTRODUCTION

### Problem and Background

The military services are continually confronted with seemingly unmanageable personnel assignment problems. During FY83, approximately 1,300,000 permanent change of station (PCS) moves were initiated by the Navy. Since PCS funds are increasingly constrained by a tighter budget, procedures to reduce PCS costs without compromising military effectiveness have to be devised.

Actually, the total number of PCS moves have decreased by more than 60 percent over the last decade--falling from 3,620,000 in 1971 to 1,304,820 in 1981. At the same time, PCS costs--disbursements that cover per diem and moving expenses of military personnel in transit between duty assignments--have skyrocketed, largely because of spiralling inflation. In 1971, the average cost of a PCS move was $370, compared to $1705 in 1981. These seemingly contradictory PCS cost trends are shown in Figure 1, which shows that the total PCS outlay in 1981 was $2.2 billion, compared to $1.4 billion in 1978 (OASD, 1983).

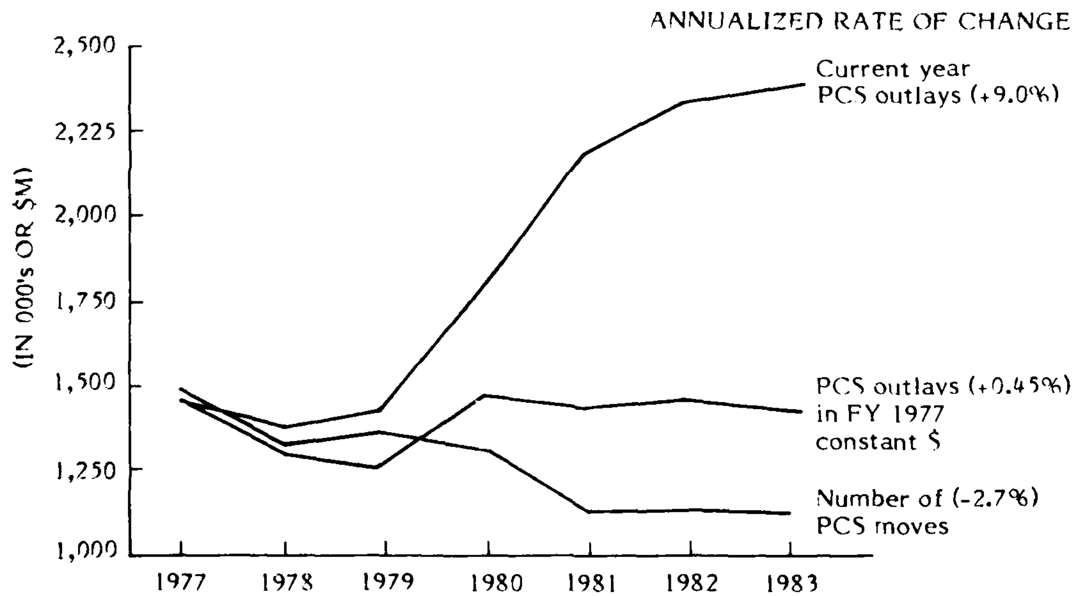


Figure 1. PCS cost trends--all categories.

At present, PCS costs are estimated by manually searching through official distance tables (Secretaries, 1982) to determine the mileage between two assignment points and consulting cost tables (Department of the Navy, 1983). Since there are approximately 500 Navy duty stations in the Continental U.S. (CONUS), searching through these tables would be time-consuming even if the data therein were stored as a computer datafile. There are 500 x 500 or 250,000 different from-to combinations.

PCS policies, procedures, and funding have been of special interest to Congress, the Office of the Secretary of Defense (OASD), and the military services for many years (Jacobson, 1983; Hansen & Handforth, 1983; Williams, 1974a, 1974b). A focal point of

research efforts regarding PCS issues relates principally to finding an easily implemented PCS costing algorithm with high efficiency and accuracy. Malone (1973) used facilities location models (Love & Morris, 1972) and mathematical functions (Crone, 1966; Hutchins, Prather, Barefoot, Flint, & Letsky, 1973) to estimate spherical distances between two points on a map. The merit of his method lies in the simplicity of the data structure and efficient calculation of spherical distances. However, the computation of PCS move costs relies heavily on the actual mileage traveled between two duty stations, a distance that can often be quite different from the spherical distance, particularly when the two stations are separated by mountains or lakes.

### Objective

The purpose of this project was to devleop a new PCS cost-estimation model that automates the process of calculating PCS move costs. The tedious tasks of paging through the official tables of distances and PCS costs are replaced by a network model (Wong & Jerardo, in press) and supporting algorithm that integrate the computation of mileage and cost into one operation. This model is hereafter referred to as the PCS cost-generation model (PCSMOD).

## PCS COST-GENERATION MODEL (PCSMOD)

### The Network Model

PCSMOD, the proposed alternative to searching through official distance tables, is a network model representing all Navy duty bases and the distances between adjacent bases. This model would not only reduce data storage requirements, but also facilitate the task of estimating the distance between two nonadjacent points. A network algorithm can readily be applied to search for the shortest path between the two points, the distance being the sum of individual mileages between all points along the chosen path. The basic structure resembles a road map with Navy duty stations represented by "nodes" and the direct routes between them represented by "arcs." The form of transportation assumed in this case (i.e., CONUS only) is land transportation, which is, in turn, reflected by PCS costs.

The two-dimensional network can mathematically be represented as

$$G = \{ N, E \}$$

where

G is the network,

N is the set of nodes $\{a_1, a_2, \ldots, a_I\}$, and

E is the set of arcs $\{e_1, e_2, \ldots, e_J\}$.

A graphical representation of a network appears in Figure 2. The direction of an arc is indicated by the order of the two nodes that define it; that is, an arc $(a_1, a_2)$ is "directed" from node $a_1$ to node $a_2$. A path in a network can then be defined as a sequence of directed arcs. For example, the path from node 2 to node 6 in Figure 2 is represented as

$$\{ (2,4), (4,5), (5,6) \}.$$

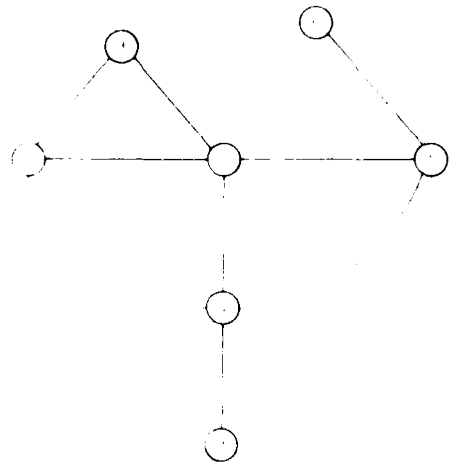

Figure 2. Graphical representation of a network.

The network G consisting of I nodes and J directed arcs may also be represented by a node-arc incident matrix $A = (A_{ij})$ , $i = 1,2,...,I$ and $j = 1,2,...,J$ such that

$$A = \begin{cases} +1 \text{ if arc } e_j \text{ is directed away from node } a_i, \\ -1 \text{ if arc } e_j \text{ is directed toward node } a_i, \text{ and} \\ 0 \text{ if arc } e_j \text{ does not exist.} \end{cases}$$

Hence, the network in Figure 2 consists of 7 nodes and 18 directed arcs:

$e_1 = (1,2)$, $e_2 = (1,3)$, $e_3 = (1,4)$, $e_4 = (1,5)$, $e_5 = (2,1)$, $e_6 = (2,3)$, $e_7 = (2,4)$, $e_8 = (3,1)$, $e_9 = (3,2)$, $e_{10} = (4,1)$, $e_{11} = (4,2)$, $e_{12} = (4,5)$, $e_{13} = (4,7)$, $e_{14} = (5,1)$, $e_{15} = (5,4)$, $e_{16} = (5,6)$, $e_{17} = (6,5)$, $e_{18} = (7,4)$.

The node-arc incident matrix A can then be specified as

$$A = \begin{bmatrix} 1 & 1 & 1 & 1 & -1 & 0 & 0 & -1 & 0 & -1 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 \\ -1 & 0 & 0 & 0 & 1 & 1 & 1 & 0 & -1 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & -1 & 0 & 0 & 0 & -1 & 0 & 1 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & -1 & 0 & 0 & 0 & -1 & 0 & 0 & 1 & 1 & 1 & 1 & 0 & -1 & 0 & 0 & -1 \\ 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 1 & 1 & 1 & -1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 1 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -1 & 0 & 0 & 0 & 0 & 1 \end{bmatrix}$$

Hence, the first row in A enumerates all the arcs directed toward and away from node 1.

## Shortest-path Problem

Given the network structure A in matrix form above, the problem of finding the shortest path between any two nodes can be formulated as a special case of a linear-network problem:

$$\begin{array}{ll} \text{Minimize} & \underline{c}\,\underline{x} \\ \text{subject to} & \underline{A}\,\underline{x} = \underline{r} \\ & \underline{x} \geq 0 \end{array}$$

where

$\underline{x}$ is a (J by 1) vector denoting the amount of "flow" through the set of directed arcs $E = \{e_1,\ldots,e_J\}$,

$\underline{c}$ is a (1 by J) vector of mileages associated with E,

A is the (I by J) node-arc incident matrix, and

$\underline{r}$ is an (I by 1) vector of flow requirements associated with the set of nodes $N = \{a_1,\ldots,a_I\}$.

The values of $r_i$ are specified as

$$r_i = \begin{cases} 1 \text{ if the node } a_i \text{ is the origin,} \\ 0 \text{ if the node } a_i \text{ is an intermediate node, and} \\ -1 \text{ if the node } a_i \text{ is the destination.} \end{cases}$$

This optimization problem can be solved by NETFLO, an algorithm written by Kennington and Helgason (1980) (also see Grinold & Marshall, 1977; Thesen, 1978). NETFLO is incorporated as a submodule of PCSMOD.

Note that the shortest path between two nodes is determined by the smallest sum of mileages associated with the intervening directed arcs; that is, by $\underline{c}\,\underline{x} = \sum_{j=1}^{J} c_j x_j$.

## Network Data Base

Three essential data files were created as input to NETFLO:

1. The first data file, MAP, contains 532 Navy duty bases (points) within CONUS, including a few route-intersection points. In addition, MAP contains 3232 directed arcs connecting all 532 points (i.e., nodes).

2. The second data file, LINK, specifies the number of arcs directed toward each node.

3. The last data file, MILE, contains the distance in miles for each arc.

All input requirements to execute PCSMOD are entered via a user-friendly query mode. The user is queried as to the individual's assignment stations (including temporary duty stations), pay grade, and number of dependents. NETFLO then determines the shortest path and distance of the move, while stored PCS cost tables provide the corresponding cost.

## Model Mileage Estimates

The shortest-path algorithm can now be applied to the network of Navy duty stations, as represented by the node-arc incident matrix and the network data base. Consider the problem of finding the distance between Norfolk, Virginia, and Brooks Air Force Base, Texas. In Table 1, the intermediate nodes along the shortest route between the two assignment points are enumerated after execution of NETFLO. As shown, the total

estimated mileage is 1,547, compared to 1,568 in the official distance tables. Thus, the percentage error is less than 1 percent.

Table 1
Shortest Path Breakdown

| Departure Point | Arrival Point | Distance |
|---|---|---|
| Norfolk, VA | Portsmouth, VA | 11 |
| Portsmouth, VA | Driver, VA | 10 |
| Driver, VA | Rocky Mount, NC | 110 |
| Rocky Mount, NC | Raleigh, NC | 53 |
| Raleigh, NC | Chapel Hill, NC | 24 |
| Chapel Hill, NC | Charlotte, NC | 90 |
| Charlotte, NC | Spartanburg, SC | 74 |
| Spartanburg, SC | Greenville, SC | 33 |
| Greenville, SC | Atlanta, GA | 144 |
| Atlanta, GA | Houston, TX | 806 |
| Houston, TX | Fort Sam Houston, TX | 188 |
| Fort Sam Houston, TX | San Antonio, TX | 4 |
| Total | | 1,547 |

Table 2, which compares computed and official distances for a wide range of randomly selected points, shows that the difference between the model's estimates and official figures were small. The percentage errors are consistently less than 2 percent. In all cases but one, the model overestimates the distance. The primary reason for the overestimation is the input of unofficial destinations and mileage figures not found in the official distance tables. Rounding upward of fractional miles also inflated the model's results.

Table 2
Distance Comparisons

| Departure Point | Arrival Point | Model Estimate | Official Distances | Difference (M - O) |
|---|---|---|---|---|
| San Diego, CA | Great Lakes, IL | 2,127 | 2,116 | 11 |
| Cincinnati, OH | Tampa, FL | 990 | 961 | 29 |
| Norfolk, VA | Houston, TX | 1,378 | 1,384 | -6 |
| Norfolk, VA | Seattle, WA | 2,953 | 2,907 | 46 |
| Bangor, ME | San Diego, CA | 3,295 | 3,261 | 34 |
| Lafayette, LA | Norfolk, VA | 1,162 | 1,151 | 11 |
| Toledo, OH | Norfolk, VA | 662 | 657 | 5 |
| San Antonio, TX | Cincinnati, OH | 1,216 | 1,198 | 18 |
| Norfolk, VA | White Sands, NM | 1,994 | 1,966 | 28 |
| China Lake, CA | Norfolk, VA | 2,683 | 2,649 | 34 |

PCS Cost Calculation

Costing a typical PCS move in CONUS proceeds as follows. A user-friendly computer system queries the user about the individual's pay grade, number of dependents, and the potential itinerary, including any temporary duty assignments. An example of a typical session can be found in Figure 3 (user reply is underlined). The itinerary, which includes the individual's old and new permanent duty stations, is input into the network model and distances are estimated. The member's travel per diem is a function of the individual's travel from his/her old permanent duty station to any temporary duty station and then on to the new permanent duty station. Temporary duty per diem depends on the location of the temporary duty and the number of days spent there. Finally, the cost of moving the individual's family and household goods depends on his/her pay grade, the distance from the old permanent duty station to the new one, and the number of dependents. The sum of all these costs is the individual's entitlement. A sample of the actual PCS cost summary output is shown in Figure 4. In this example, the enlisted person was assigned from Norfolk, Virginia to Oakland, California with a 30-day temporary duty stint at Brooks AFB, Texas. Again, note that per diem rates for enlistees depend on the pay-grade level.

PAY GRADE, PLEASE? E-7

NUMBER OF DEPENDENTS? 3

HOW MANY DAYS OF TEMPORARY DUTY? 30

TEMPORARY DUTY STATION, CITY AND STATE, PLEASE? San Diego, CA
{This question is asked only if reply to previous question is greater than zero.}

TEMPORARY DUTY FOR WHICH SERVICE BRANCH?
1 = Navy
2 = Marines
3 = Air Force
4 - Army
1

OLD PERMANENT DUTY STATION, CITY AND STATE, PLEASE? Washington, DC

NEW PERMANENT DUTY STATION, CITY AND STATE, PLEASE? Norfolk, VA

IS THE FOLLOWING INFORMATION CORRECT? IF ALL IS CORRECT, TYPE 0. IF ANY LINE IS INCORRECT, TYPE IN THE LINE NUMBER.

PAY GRADE: E-7
NUMBER OF DEPENDENTS: 3
TEMPORARY DUTY DAYS: 30
TEMPORARY DUTY STATION: San Diego, CA
BRANCH OF SERVICE: Navy
OLD PERMANENT DUTY STATION: Washington, DC
NEW PERMANENT DUTY STATION: Norfolk, VA

0

---

End of session. The model proceeds to the mileage network module and subsequently to the costing algorithm.

Figure 3. Example of PCS cost query session (user reply is underlined).

Member: E-7
Dependents: 3

Itinerary:

| | | | |
|---|---|---|---|
| Old permanent duty station: | Norfolk, | VA | |
| Temporary duty station: | Brooks AFB, | TX | 30 days |
| New permanent duty station: | Oakland, | CA | |

Member Mileage:

| | |
|---|---|
| Norfolk, VA to Brooks AFB, TX | 1,554 miles |
| Brooks AFB, TX to Oakland, CA | 1,730 Miles |
| Total member mileage | 3,284 miles |

Member Household Goods Mileage:

| | |
|---|---|
| Norfolk, VA to Oakland, CA | 2,996 miles |

Cost Construction:

| | | | |
|---|---|---|---|
| Member military allowance for travel (MALT)/per diem (PD) | = $ | 930 | (MBR MALT/PD Line; 3,284 miles) |
| Temporary duty per diem | = $ | 360 | (30 Days x $12 per day) |
| Household goods/dependents | = $ | 7,955 | (E-7; 3 Deps; 2996 miles) |
| | $ | 0 | (ea addl dep line; 2,996 miles; $105 x 0 = 0) |
| Total estimated cost | = $ | 9,245 | |

Figure 4. Example of actual PCS cost summary output.

PCS Accounting Subsystem

To enable managers to monitor PCS expenditures, a supplemental program was devised to systematically update the PCS budget balance. By promptly deducting every PCS cost expense from the current balance, the remaining funds are tracked continuously. A sample of the summary output appears in Table 3. Various average cost statistics for each pay-grade level are provided, along with the original PCS budget, the cumulative outlays, and the new budget balance.

Table 3
Supplemental PCS Cost Statistics

| | Average Cost Per Move | | | Percent of Total Expended for | | | Average Cost of Move/Mile | | Avg Cost of TDY Per Day |
|---|---|---|---|---|---|---|---|---|---|
| | Total | HHGS | TDY | Total | HHGS | TDY | HHGS | TDY | |
| E-4 | 3,206 | 2,387 | 844 | 21 | 20 | 33 | 1.49 | 0.28 | 40 |
| E-5 | 5,800 | 4,956 | 845 | 34 | 38 | 30 | 3.10 | 0.28 | 39 |
| E-6 | 5,600 | 4,347 | 845 | 25 | 26 | 23 | 2.72 | 0.28 | 40 |
| E-7 | 5,600 | 4,700 | 844 | 11 | 12 | 10 | 2.94 | 0.28 | 40 |
| E-8 | 11,437 | 2,857 | 845 | 6 | 2 | 3 | 1.79 | 0.28 | 40 |
| E-9 | 12,497 | 4,169 | 844 | 3 | 1 | 1 | 2.60 | 0.28 | 40 |

Total funds available: $620,000,000.00
Total spent to date: $511,689,056.00
Balance remaining $108,310,944.00

HHGS: Household Goods
TDY: Temporary Duty

## DISCUSSION AND CONCLUSIONS

An automated system for PCS cost computation has been developed and tested. Based on comparative efficiency, PCSMOD is decidedly preferable to the present practice of consulting official tables of distances and PCS costs by hand. (PCSMOD would still be less time-consuming and more labor-saving even if the distance and cost tables can be electronically retrieved.) The tradeoff in accuracy in estimating the shortest-path distance from a network model is minimal and insignificant.

The major hurdle in automating PCS cost estimation was the construction of the vast network of Navy duty stations. Even though the mileage between adjacent nodes conformed with official figures, it was found that, as the distance between two nonadjacent nodes increased, the percentage error tended to get larger. This occurs because the distance along a direct route does not normally coincide with the sum of individual mileages along the determined shortest path. To enhance precision, the network had to be augmented with long arcs directly connecting major Navy homebases. The resulting accuracy of an average 2 percent error is critical since the mileage estimate is the dominant factor in determining PCS cost.

The other component of the system that requires greater efficiency is PCS cost computation. Despite PCSMOD's capability to scan stored PCS cost tables, the process can be time-consuming. If a set of regression equations that precisely estimate total PCS cost is used in place of the cost tables, costing a move would be expedited. Least squares estimation is appropriate for this purpose since PCS cost can be modeled as a linear function of the distance traveled, pay grade level, and the number of dependents.

Representative regression equations of the enlisted PCS cost table (for CONUS/Canada/-Mexico) were found to have highly significant coefficients of determination (R square values > .98).

Since PCSMOD is designed as a portable system, it can easily be adapted by the other armed services and even by other federal agencies for the same or related uses. PCSMOD can readily be expanded to include overseas Navy bases as well as PCS moves by officers. Furthermore, it is flexible enough to accommodate enhancements of accounting and statistical capabilities.

Another approach currently being tested involves the concept of "neighboring" nodes, which partitions a large-size network into a nested structure of groups of nodes called neighborhoods. The shortest path between two locations is then found by solving a sequence of similar problems of reconstructed networks. As the sizes of reconstructed networks are considerably smaller, the efficiency as well as accuracy of the new algorithm will be greatly improved.

## RECOMMENDATIONS

Navy Military Personnel Command (NMPC-4) should implement PCSMOD to estimate the cost of CONUS moves as part of the enlisted detailing process. As a result of the successful development of PCSMOD, it is further recommended that an enhanced version of PCSMOD that includes both overseas and officer assignments be developed by NAVPERSRANDCEN for NMPC-4 implementation as part of the detailing/order writing process.

Technically, it is recommended that further increases in speed be researched by NAVPERESRANDCEN by adding additional arcs (direct routes) connnecting major Navy bases.

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# SUPPLEMENTARY

# INFORMATION

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Subj: NPRDC TR 84-52, Permanent Change of Station (PCS) Cost-Generation Model (PCSMOD), Aug 1984

Encl: (1) Change Summary page vii and page 1 of NPRDC TR 84-52

1. During FY83, approximately 300,000 permanent change of station (PCS) moves were initiated by the Navy. This figure was erroneously worded as 1,300,000 in the technical report.

2. As this technical report will be used as a reference in the future development of PCSMOD, it is requested that the introduction and summary pages be replaced by enclosure (1).

J Silverman
JOE SILVERMAN

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(See page 2)

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## SUMMARY

### Problem

The military services are continually confronted with seemingly unmanageable personnel assignment problems. During FY83, approximately 300,000 permanent change of station (PCS) moves were initiated by the Navy. However, since PCS funds are increasingly constrained by a tighter budget, procedures to reduce PCS costs without compromising military effectiveness have to be devised.

One step in controlling PCS outlays is to upgrade PCS cost computation. At present, PCS cost estimation involves a manual search through official distance and cost tables. This process is inefficient and error-prone.

### Objective

The purpose of this effort was to develop a new PCS cost-estimation model that automates the process of calculating the cost of a PCS move. The tedious tasks of paging through the official tables of distances and PCS costs are replaced by a network model that integrates the computations of mileage and cost in one operation.

### Approach

PCS costs are computed automatically by the following procedure:

1. The network structure of Navy duty stations in the continental U.S. (CONUS) is represented in matrix form.

2. A linear optimization algorithm is developed to find the shortest path between any pair of stations in the network.

3. The estimated total distance of this path, the individual's pay grade, and the number of dependents are input into a PCS cost generation model (PCSMOD) that computes the total PCS cost of a move.

### Results and Conclusions

The network model performed impressively: Shortest-path distances deviated from official mileages by an average error of 2 percent. No problems were encountered in specifying the appropriate costs of sample itineraries. PCSMOD has successfully combined in a single operation the previously unautomated tasks of distance and PCS cost computation. Thus, PCSMOD solves two complex problems. First, its output serves as input to the career management planner, which optimizes over total PCS expenditures, performance, and retention in planning optimal career assignments. Second, it can be used in place of official distance and PCS cost tables to facilitate the Navy's PCS costing operation. Also, PCSMOD allows managers to keep track of the PCS budget balance.

### Recommendations and Future Plans

Navy Military Personnel Command (NMPC-4) should implement PCSMOD to estimate the cost of CONUS moves as part of the enlisted detailing process. As a result of the successful development of PCSMOD, it is further recommended that an enhanced version

# INTRODUCTION

## Problem and Background

The military services are continually confronted with seemingly unmanageable personnel assignment problems. During FY83, approximately 300,000 permanent change of station (PCS) moves were initiated by the Navy. Since PCS funds are increasingly constrained by a tighter budget, procedures to reduce PCS costs without compromising military effectiveness have to be devised.

Actually, the total number of PCS moves have decreased by more than 60 percent over the last decade--falling from 3,620,000 in 1971 to 1,304,820 in 1981. At the same time, PCS costs--disbursements that cover per diem and moving expenses of military personnel in transit between duty assignments--have skyrocketed, largely because of spiralling inflation. In 1971, the average cost of a PCS move was $370, compared to $1705 in 1981. These seemingly contradictory PCS cost trends are shown in Figure 1, which shows that the total PCS outlay in 1981 was $2.2 billion, compared to $1.4 billion in 1978 (OASD, 1983).

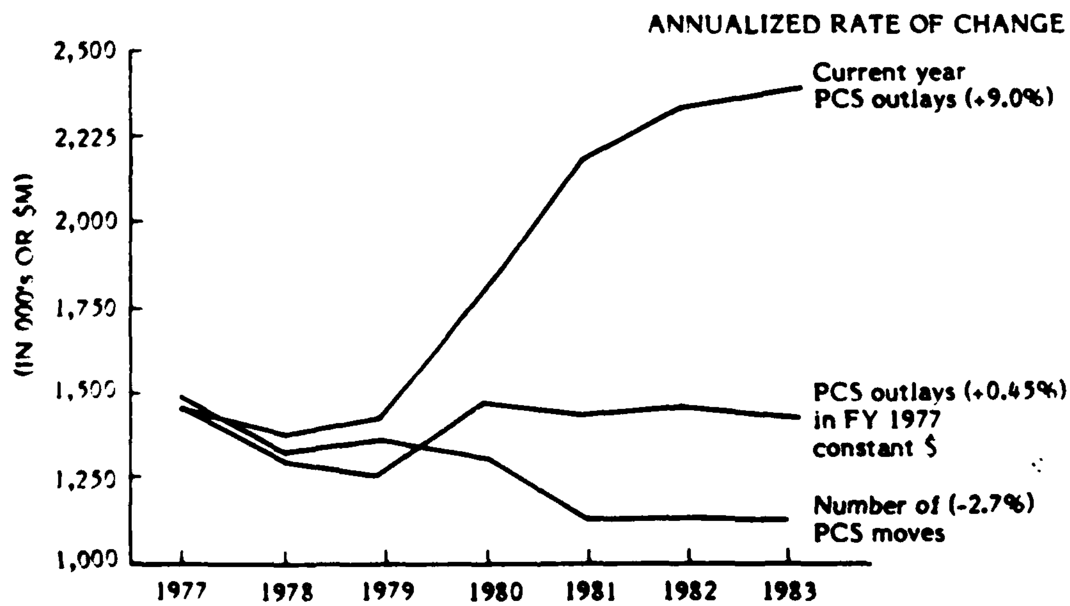


Figure 1. PCS cost trends—all categories.

At present, PCS costs are estimated by manually searching through official distance tables (Secretaries, 1982) to determine the mileage between two assignment points and consulting cost tables (Department of the Navy, 1983). Since there are approximately 500 Navy duty stations in the Continental U.S. (CONUS), searching through these tables would be time-consuming even if the data therein were stored as a computer datafile. There are 500 x 500 or 250,000 different from-to combinations.

PCS policies, procedures, and funding have been of special interest to Congress, the Office of the Secretary of Defense (OASD), and the military services for many years (Jacobson, 1983; Hansen & Handforth, 1983; Williams, 1974a, 1974b). A focal point of